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**AERONAUTICAL DECISION-MAKING AND
UNIVERSITY AVIATION ASSOCIATION
CERTIFIED FLIGHT INSTRUCTORS**

Terry S. Bowman

Aviation experts and researchers have long known that pilot error is the major cause of aircraft accidents. Estimates of pilot error as a contributor to aviation accidents range from 50 to 90% (Diehl, 1989). The National Transportation Safety Board (NTSB) reported in its 1991 review of general-aviation accidents that the pilot was the broad-cause factor in 86.6% of all general-aviation accidents that occurred in 1988.

In the 1970s, as more human factors specialists entered the aviation safety field, investigators and safety specialists began to place emphasis on the behavioral aspects of aircraft accident preventive measures. The focus was on the "why" of pilot error in the hope of lowering the accident rate. Early in the 1980s, the NTSB began performing human analyses and gathering human factors data during investigations (Nance, 1986). Also, in 1980 the NTSB established a human-performance division with an expanded staff of specialists (Diehl, 1989).

PURPOSE

The purpose of this article is to present an analysis of data from a survey instrument mailed to University Aviation Association (UAA) members on the January 1993 roster. The questionnaire was designed to measure the attitudes of UAA members toward pilot judgment and decision-making training, to determine if their attitudes differed based on aviation experience and expertise, and to get their opinions of possible constraints to inclusion of this training in existing aviation curricula. Part 5 of this survey instrument, which was restricted to responses from those who held a Certified Flight Instructor (CFI) certification from the Federal Aviation Administration (FAA), focused on how CFI respondents applied Aeronautical Decision Making (ADM) training as an instructor or evaluator of student skills and knowledge.

LITERATURE REVIEW

Human factors, as it relates to aviation safety, has been defined by a number of authors. Most agree that the terms human factors and ergonomics are synonymous and mean man and his work or, more recently, people and their activities (Edwards, 1988). Trollip and Jensen (1991) provide a human factors definition specific to general aviation:

The study of how people interact with their environments. In the case of general aviation, it is the study of how pilot performance is influenced by such issues as the design of cockpits, the functions of organs of the body, the effects of emotions, and the interaction and communication with the other participants of the aviation community, such as other crew members and air traffic control personnel. (pp. 1-2)

The International Civil Aviation Organization (ICAO) views aviation human factors as primarily oriented toward solving practical problems in the real world. In its 1991 publication, *Human Factors Digest No. 3: Training of Operational Personnel In Human Factors*, the ICAO included decision-making as a required skill area in three out of five human factors training areas and included exercise of judgment as a required skill area in one of the two remaining training areas. Thus, pilot judgment and decision-making can be viewed as a subtopic of aviation human factors training.

Jensen and Benel's 1977 study showed that 51.6% of fatal pilot-caused accidents in general aviation in 1970-74 resulted from faulty decision-making behavior. A more recent study of general aviation pilot-error accidents that

occurred in 1983-88 revealed that faulty in-flight judgment accounted for 18% of the fatal accidents, and faulty preflight judgment accounted for 20% of the fatal accidents. That figure does not include other types of pilot error, such as flying skills, fuel management, and alcohol/drugs that probably include some component of judgment and decision-making and which, in total, accounted for 64% of the fatal general-aviation accidents that occurred in this same time frame (Oster, Strong, & Zorn, 1992).

Jensen and Benel's (1977) review of the literature on complex human judgment by medical diagnosticians, stockbrokers, and businesspersons led them to conclude that pilot judgment and decision-making could be taught and evaluated. A 1978 study at Embry-Riddle Aeronautical University (ERAU) began the development and validation of judgment training materials for student and instructor pilots. The result, significant at the .001 level of confidence, showed that those student pilots who received judgment training from specially trained instructors and the newly developed manuals demonstrated observable benefits from the training when compared to pilots who had not received the training (Berlin et al., 1982). A 1982 study applied the ERAU manuals to a six-week program with Canadian Air Cadets, resulting in 50% fewer decision errors in a structured test by those cadets who underwent the classroom and flight judgment training (Buch & Diehl, 1984). Additional studies were conducted by Transport Canada, the Quebec Department of Education in the Chicoutimi College flight-training program, the U.S. FAA (Telfer, 1989) and in Australia (Telfer & Ashman, 1986). All these studies had similar positive results.

In 1987, after 12 years of research and development, six manuals on the decision-making needs of variously rated pilots were published by the FAA under the broad title of *Aeronautical Decision Making* (ADM). According to the FAA (1991), the effectiveness of these materials was validated in six independent studies. All six ADM manuals are available from the National Technical Information service for a nominal fee. Although the FAA has not yet mandated ADM training for those seeking FAA pilot certifications and ratings, it has strongly endorsed the concept by publishing guidance

for such training in the 1991 FAA Advisory Circular Number 60-22, *Aeronautical Decision Making*.

The FAA (R. L. Kruse, personal communication, Nov. 18, 1993) indicates that it is considering including ADM in upcoming revisions to CFR Part 61 and new FAA Airplane Flight Training Handbooks. The proposed revisions would make ADM a topic of the Part 61 knowledge requirements for each level of certification. However, the flight-training handbooks would have limited ADM detail because this subject is covered in other FAA documents such as Advisory Circular 60-22.

Schukert's 1992 *Post-Secondary Aviation & Space Education Reference Guide* lists 197 post-secondary aviation education institutions in the United States that offer aviation flight training, ranging from private pilot to professional pilot baccalaureate degree programs. A survey revealed that at least 15,185 students were enrolled in some type of flight training at these institutions during the Spring 1993 semester (Bowman, 1993). Except for those who begin their flight careers with the military, nearly all U.S. pilots receive their initial training and flight experience as general-aviation pilots. Thus, the flight training and instruction offered by these institutions have the potential to substantially improve general-aviation accident rates by incorporating ADM into the curriculum. However, until recently the attitude of certified instructors employed by post-secondary aviation educational institutions toward ADM, their training in ADM, and their related instructional practices were not known.

METHOD

The data for this study resulted from much broader research completed in July 1993 (Bowman, 1993). The purpose of that research was to determine the extent to which pilot judgment and decision-making training had been incorporated into aviation flight curricula at post-secondary institutions in the United States. The attitudes of aviation educators to pilot judgment and decision-making training were also measured. The method used for the research was a non-experimental, descriptive design that used two separate survey instruments to collect data from two populations: post-secondary educational institutions offering some form of pilot training and the individual

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Table 1
UAA Respondents by Reported Demographics

Membership Status	Total	Number Reported as	
		Pilot	CFI
Non-Flight Faculty	107 (43.0%)	80 (74.8%)	54 (50.5%)
CFI	74 (29.7%)	74 (100.0%)	74 (100.0%)
Member of Industry	28 (11.2%)	22 (78.6%)	14 (50.0%)
Govt. Employee	17 (6.8%)	13 (76.5%)	4 (23.5%)
Other (retired, etc.)	23 (9.2%)	20 (87.0%)	10 (43.5%)
Total	249 (100%)	209 (83.9%)	156 (62.7%)

NOTE: Totals may not equal 100% due to rounding.

members of the UAA.

This study focuses on the data from Part 5 of a five-part instrument mailed to the 353 individual members of the UAA listed on the January 1993 roster. The questionnaire was designed to measure attitudes of the UAA members toward pilot judgment and decision-making training, to determine if their attitudes differed based on aviation experiences and expertise, and to get their opinions of possible constraints to inclusion of this training in existing aviation curricula. Part 1 asked for demographic data; Part 2 measured respondents' degree of agreement to including the nine primary curricular elements of pilot judgment and decision-making training in an aviation flight curriculum; Part 3 measured degrees of agreement to six possible constraints to including the nine topics in aviation flight curricula; Part 4 measured respondent support for mandating this type of training; and Part 5, which was restricted to responses from CFIs, asked six questions related to how the CFI respondents applied ADM training as instructors and/or evaluators of student knowledge.

Both questionnaires were mailed in April 1993, with a followup mailing in early May 1993. Of the 353 questionnaires mailed to UAA members, 18 were undeliverable, 259 were returned, and 249 of those were usable. The overall usable rate of 74.33% was calculated as the number of usable returns divided by the number

mailed, less those undeliverable (Hopkins, 1976). The data from Part 5 of the questionnaire mailed to UAA members were tabulated according to response frequencies and a table was constructed to permit relating the response frequencies to each of the six questions. A review of the data in this form permitted judgments to be made on the treatment of ADM by the UAA member CFIs.

RESULTS

The demographic section of the UAA membership questionnaire asked the respondents to classify themselves as either current or former non-flight faculty, CFI, member of industry, government employee, or other (see Table 1). In addition, respondents were asked if they were or had been an FAA

certificated pilot and, if so, to indicate all certifications and ratings they held. Although only 74 (29.7%) of the 249 respondents classified themselves as current or former CFIs, a total of 156 (62.65%) stated that they had held the FAA CFI certification and responded to Part 5 of the questionnaire.

When asked if they made it a regular practice to specifically instruct their students in ADM in accordance with FAA Advisory Circular Number 60-22, 66% of the 156 who responded to Part 5 of the questionnaire agreed or strongly agreed, 25% of the respondents were neutral, and 9% disagreed or strongly disagreed. When asked if they made it a regular practice to specifically evaluate their students for the ability to exercise good ADM, 87.8% agreed or strongly agreed. A significant majority (94.3%) of the respondents agreed or strongly agreed that it is incumbent upon all flight instructors to ensure that their students understand and are able to exercise good ADM. Only 6.4% of the respondents reported that they had never failed a student on a flight certification or rating evaluation based on the student's display of poor pilot judgment or decision-making.

A full 64% of the 156 CFI respondents indicated that they had not personally received formal training or instruction on ADM or on pilot judgment and decision-making. Forty-six (29.5%) of the CFI respondents stated they had personally received training

and instruction on both ADM and pilot judgment and decision-making. Ten additional respondents indicated they had received training and instruction on pilot judgment and decision-making other than the FAA's ADM. Table 2 details the responses to the six questions.

DISCUSSION

Hunt and Ashcroft (cited in Telfer, 1989) identified three means of improving pilot judgment in their report to the Civil Aviation Division of the New Zealand Ministry of Transport:

1. Select pilots who have appropriate characteristics;
2. Attain judgment through luck and caution in experience over time;
3. Provide explicit training and assessment.

It appears that there may be a type of natural selection of those wishing to be pilots in the system used to train and certify them. Certainly, not all who want to be pilots possess the requisite talents and other characteristics, whatever they may be. Students drop out at all levels of training and certification, which may be a factor in keeping the pilot-error accident rate in general aviation from being greater than it is, but their dropping out does not help reduce the rate.

Other data suggest that time and experience may be a positive factor in reducing a pilot's potential to be involved in a pilot-error initiated accident. Oster et al. (1992) found a clear progression in the role of pilot error as pilots advance from general aviation through Part 135 operations to Part 121 operations. Oster et al.'s study shows the percentage of accidents initiated by pilot error in 1979-88 to be 65% for general aviation, 42% for air taxi, 36% for commuter operations, and 11% for scheduled jet service. Oster et al. also found that the pilot-error rate for commuters during the period 1986-88 to be six times higher than for 1979-85. Oster et al. (1992) attribute this higher rate to the increased rate at which pilots advanced from the commuter industry to the jet carrier industry during this time and subsequent replacement of commuter vacancies with relatively less experienced pilots from the air taxi and Part 135 cargo segments. Also, as pilots advance from general aviation to Part 135 and Part 121 operations they are operating more sophisticated equipment with the benefit of training

and greater supervision under increased regulation. However, the reliance on time and experience to reduce the overall pilot-error accident rate does not help the inexperienced general-aviation pilot who operates alone and unsupervised in the least sophisticated types of aircraft.

The importance of pilot judgment and decision-making training to the safety of flight is well documented. Researchers such as Buch and Diehl (1984) suggest that it is possible to lower the existing accident rates by training pilots to exercise better judgment and decision making. Connolly (1990) has shown that this training can be effective for both novice and experienced pilots. ADM, effectively incorporated into aviation flight curricula and applied to all levels of pilot training, has the potential to significantly reduce the greatest cause of general-aviation accidents and to improve aviation safety in all other industry categories.

The data from this study suggest that UAA member CFIs are well aware of the importance of ADM to the training of pilots. However, it does not tell us anything of non-respondent CFIs. We know from the data that only 6.4% of the respondent CFIs have never failed a student based on the student's display of poor pilot judgment or decision-making. Yet, the data do not reveal the criteria on which failures are based or anything of the circumstances. Furthermore, only 35.9% of the UAA member respondent CFIs have personally received formal training in ADM or pilot judgment and decision-making training. However, the survey did not reveal how many of the respondent and other CFIs have knowledge of ADM through self-study and other means or the extent of their knowledge of ADM training concepts and practices.

Data derived from the broader research on which this study is based revealed that 67.2% of the 122 post-secondary aviation educational institutions responding to a separate survey instrument teach at least one of the nine primary ADM curricular topics. However, that same research also revealed that 47.5% of the respondent institutions did not use a textbook that includes pilot judgment and decision-making (Bowman, 1993). One of the conclusions stated that "pilot judgment and decision-making has not been incorporated into the

*Aeronautical Decision-Making***Table 2**

Responses From UAA Members Who Are or Have Been a Certified Flight Instructor, an Assistant or Chief Flight Instructor, or a Certified FAA Examiner

Question: I make it a regular practice to specifically instruct my students in ADM in accordance with FAA Advisory Circular Number 60-22.

1	2	3	4	5	
Strongly				Strongly	
<u>Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Disagree</u>	<u>Total</u>
40 (25.6%)	63 (40.4%)	39 (25%)	9 (5.8%)	5 (3.2%)	156 (100%)

Question: I make it a regular practice to specifically evaluate my students for their ability to exercise good ADM.

1	2	3	4	5	
Strongly				Strongly	
<u>Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Disagree</u>	<u>Total</u>
78 (50%)	59 (37.8%)	13 (8.3%)	4 (2.6%)	2 (1.3%)	156 (100%)

Question: I believe it is incumbent on all flight instructors to ensure that their students understand and are able to exercise good ADM.

1	2	3	4	5	
Strongly				Strongly	
<u>Agree</u>	<u>Agree</u>	<u>Neutral</u>	<u>Disagree</u>	<u>Disagree</u>	<u>Total</u>
89 (57.1%)	58 (37.2%)	9 (5.8%)	0	0	156 (100%)

Question: While evaluating students for a flight certification or rating, have you ever failed a student based on that student's display of poor pilot judgment or poor pilot decision-making?

1	2	3	
<u>Yes, Definitely</u>	<u>Yes, Partially</u>	<u>No, Not Ever</u>	
117 (75%)	29 (18.6%)	10 (6.4%)	

Question: Out of the total number of times that I have failed students on a flight certification/rating evaluation, I estimate ____% of the failures were based on the student's display of poor pilot judgment and/or decision-making.

1	2	3	4	5	6
<u>1-5%</u>	<u>6-10%</u>	<u>11-15%</u>	<u>16-20%</u>	<u>21-25%</u>	<u>more than 25%</u>
45	36	14	19	6	26
(30.1%)	(24.7%)	(9.6%)	(13%)	(4.1%)	(17.8%)

Table 2, cont.

Question:	Have you personally received formal training or instruction on ADM as it is defined by the FAA in Advisory Circular Number 60-22?		
<u>YES</u>	<u>NO</u>	<u>TOTAL</u>	
46 (29.5%)	110 (70.5%)	156 (100%)	

Question:	Have you personally received formal training or instruction on pilot judgment and decision-making in addition to or other than the FAA defined ADM?		
<u>YES</u>	<u>NO</u>	<u>TOTAL</u>	
56 (35.9%)	100 (64.1%)	156 (100%)	

aviation flight curricula in any consistent, formally structured curriculum format." (p. 157)

The positive results obtained during pilot judgment and decision-making training research were achieved through the use of specially trained instructors and newly developed manuals (Berlin et al., 1982) as well as classroom, simulator, and flight instruction (Buch & Diehl, 1984). ADM concepts and procedures are considerably more subjective than the mechanical skills and knowledge required to fly an airplane. For ADM to be effective, both students and instructors must develop a certain amount of ADM intellect based on proven concepts and must practice the principles until ADM becomes a natural part of the instructing and flying process. ADM instruction and evaluation should be an integrated part of all ground school instruction, simulator training, flight instruction, and certification examinations. Only then is there likely to be a substantial reduction in pilot-error induced general-aviation accidents and improvements in pilot-error accident rates in other segments of the industry.

RECOMMENDATIONS

The FAA should adopt a pro-active approach to ADM as an essential part of aviation flight-training. Revising CFR Part 61 to include aeronautical decision-making and judgment within the required

aeronautical knowledge is a positive move. However, to be truly effective, ADM concepts, principles, and practices must be included as mandatory items in the oral, written, and practical certification/rating examinations.

Authors of flight-training textbooks, including the FAA, should incorporate ADM concepts and principles into every aspect of the text. ADM should be treated as a natural part of all flight instruction and procedures.

The UAA should take the lead in encouraging post-secondary aviation educational institutions to incorporate ADM training into their aviation flight curricula. The Council on Aviation Accreditation may wish to require ADM training for program accreditation.

The faculty (CFIs) should take steps to ensure their own knowledge of ADM and to develop aviation flight curricula that fully incorporate ADM's concepts. Effective ground school, simulator, and flight-instruction models incorporating ADM should be shared with collegiate aviation through appropriate publications and seminars to assist others in doing the same.

Finally, pilot judgment and decision-making training research should continue. New knowledge, better defined concepts, proven instructional techniques, and effective curriculum models can result in improved safety performance throughout the aviation industry.□

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